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PetShure | pH CONTROL SYSTEMS

TURNING IMAGINATION INTO REALITY

Balchem Research Summary

Application of Encapsulated and Dry-plated Food Acidulants (Lactic and Citric Acid) to Control *Salmonella enterica* in Raw Meat-Based Diets for Dogs

A summary of a study conducted by S. Kiprotich[1], E. Altom[2], R. Mason[2], V. Trinetta[3], and G. Aldrich[1]
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Introduction

The fresh pet food market—raw, refrigerated, and frozen products—is gaining in popularity. However, these perishable products are prone to bacterial contamination and recalls, with *Salmonella* driving 23% of pet food recalls over the past 20 years.[1] The impact of a recall can be devastating for manufacturers[2]:

- 55% of customers temporarily leave the brand
- 21% reject other products by the manufacturer
- 15% never return to the brand

This poses a dilemma—while the market offers huge potential, it also put your brand reputation and financial stability at risk. How can companies seize this opportunity without jeopardizing consumer trust?

Organic acids, such as lactic and citric acids,have commonly been added to meats as a means to control pathogen load because of their inexpensive cost and antimicrobial efficacy. These acids work by either reducing ATP production/regulation through cytoplasmic acidification or by accumulating toxic levels of dissociated anions, both of which negatively impact cell physiology and metabolism (Kiprotich et al., 2022). However, high concentrations of these acids in an unprotected form can negatively affect the quality of the meat. Microencapsulation technologies that meter acids into raw meat-based pet food gradually over time may be a solution to controlling pathogenic load while maintaining product quality. Thus, the objective of this research was to evaluate Balchem's PetShure® microencapsulated lactic or citric acid on the control of *Salmonella* enterica in raw meat-based pet food. Additionally, pH of the pet food was measured and quality was assessed via visual observations for color and texture.

Methodology

A nutritionally complete raw meat-based pet food containing turkey, sweet potato, chicken liver, carrots, and apples was ground together and subjected to 1.0, 2.0 or 3.0% (w/w) of encapsulated or raw lactic or citric acid. Negative and Positive Control mixtures were also created that did not contain any acidulants. The meat mixtures were then shaped into 100g patties and were individually stored for 2 h at 4°C. Following refrigeration, the acid-treated and positive control patties were inoculated with 0.1mL of a *Salmonella* enterica cocktail (*Salmonella* Typhimurium, *Salmonella* Heidelberg, and *Salmonella* Enteritidis) to achieve a final concentration of ~6.0 Log CFU/mL. Negative Control patties were not inoculated. The patties were allowed to sit for 30 min to allow for pathogen attachment, and then refrigerated at 4°C for 1, 4, 7, 10, 13, 16, 19 and 22 days to mimic anticipated shelf-life for refrigerated raw meat-based diets. At each timepoint, microbial analysis was performed and pH was measured for each patty. Microbial analysis was also performed prior to *Salmonella enterica* inoculation to determine presence of background *Salmonella.*

Results & Discussion

Microbial Analysis

Salmonella enterica was undetected on the negative control patties during the duration of the experiment. All acid treatments reduced *Salmonella enterica* over time when compared to the non-acidulant treated, Positive Control patties (see Figure 1 for lactic acid and Figure 2 for citric acid). After 22 days of storage, both the encapsulated lactic and citric acid at 1.0% inclusion level had higher log reductions (3.10 and 2.78 Log CFU/patty, respectively) compared to the raw acids (2.88 and 2.70 Log CFU/patty, respectively)

Figure 1. ***Salmonella enterica*** survival in patties treated with or without 1.0, 2.0 or 3.0% encapsulated or raw lactic acid.

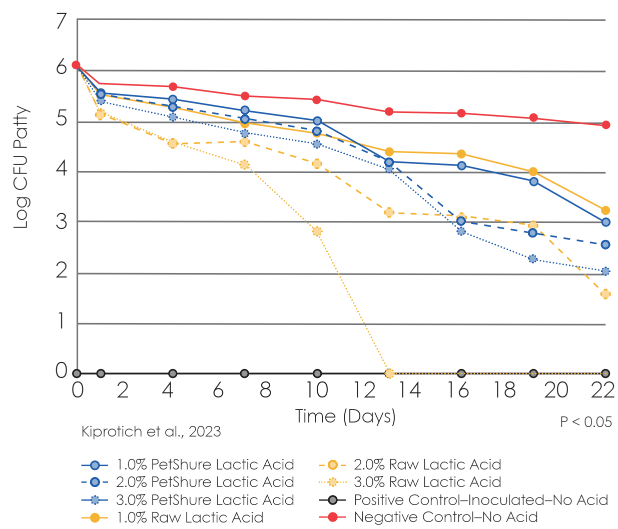
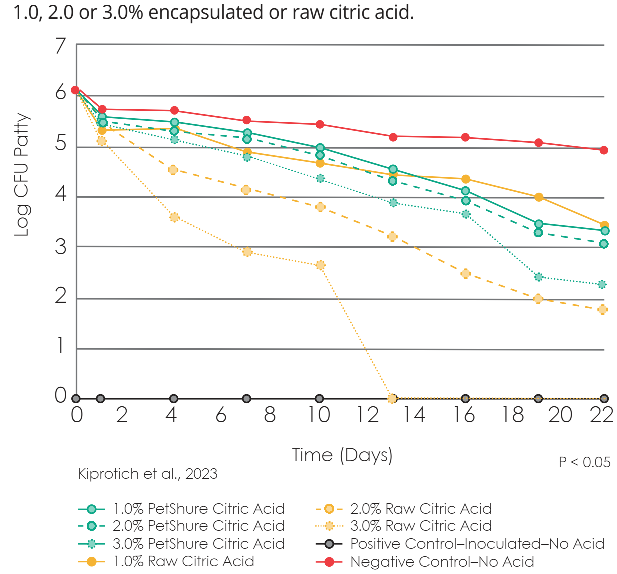
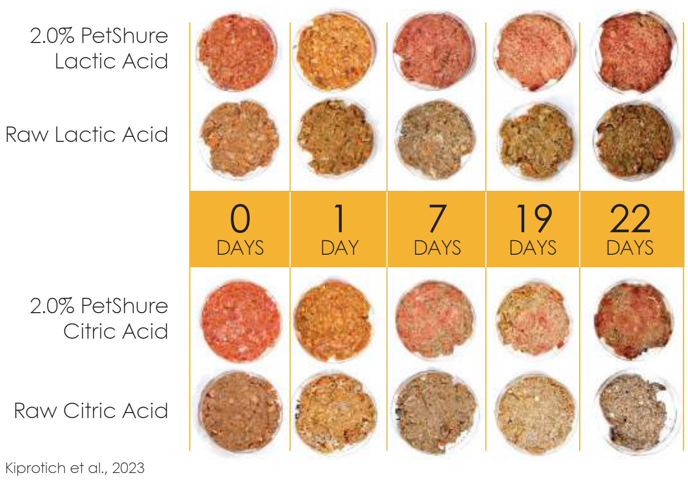


Figure 2. ***Salmonella enterica*** survival in patties treated with or without 1.0, 2.0 or 3.0% encapsulated or raw citric acid.



at the same concentrations, likely due to the gradual release of acid which circumnavigated the natural buffering capacity of the meat proteins. At 2.0% and 3.0% inclusion level, the raw lactic acid resulted in higher log reductions (4.53 and 6.09 Log CFU/patty, respectively) compared to the encapsulated acid at the same concentrations (3.55 & 4.07 Log CFU/patty, respectively). This same trend was observed for the raw and encapsulated citric acid at 2.0 and 3.0% inclusion levels (4.35 and 6.09 Log CFU/patty for raw citric, respectively, versus 3.05 & 3.84 Log CFU/patty for encapsulated citric, respectively). However, these higher inclusion levels of raw acid resulted in acid shock, creating syneresis, discoloration, weeping and visible signs of mold growth, thus, creating a lower quality patty (Figure 3).

Figure 3. Visual appearance of meat patties treated with 2.0% PetShure or raw acid



pH

Figures 4 and 5 report the pH of all patties over the 22-day experimental period for lactic and citric acid, respectively. Both control patties experienced a gradual drop in pH initially, but then leveled and began to rise toward the end of the experiment.

Figure 4. pH patties treated with or without 1.0, 2.0 or 3.0% encapsulated or raw lactic acid.

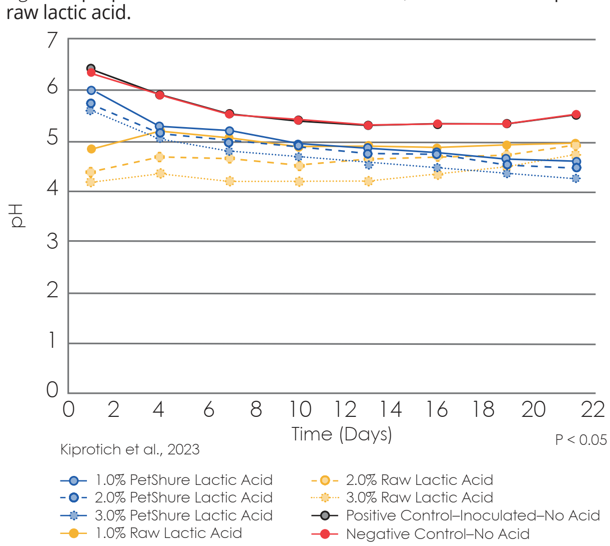
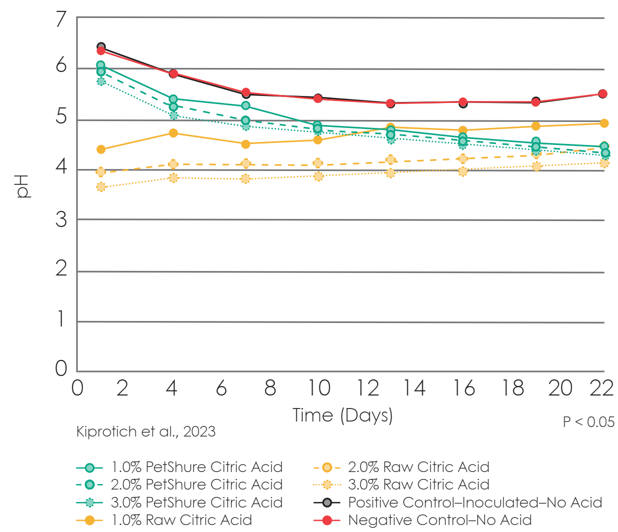


Figure 5. ***Salmonella enterica*** survivors in patties treated with or without 1.0, 2.0 or 3.0% encapsulated or raw citric acid.



The patties treated with raw acid experienced a rapid drop in pH on day 1 (1.52 – 2.71 pH units), but then increased at day 4 of storage, and either leveled or continued to rise slightly throughout theremainder of the experiment. Patties treated with either encapsulated acid had a consistent gradual drop in pH over the 22-day experiment due to the slower release of acid over time. Increasing the inclusion levels from 1.0% to 3.0% of either the raw or encapsulated acids resulted in no additional significant drop in pH. After 22 days, both the encapsulated and raw acids significantly reduced the pH of the patties (1.07 and 0.66 for lactic, respectively; 1.17 and 1.02 for citric, respectively) when compared to either the positive or negative control treatments. Although, at the end of the 22-day study, color of the patties treated with 1.0 and 2.0% encapsulated acids maintained a pink color throughout the study (Figure 3), unlike the raw acid-treated patties which changed to a gray color only 2 hours following treatment administration.

Conclusion

While direct acidification with raw acid has potent antimicrobial properties, raw meat-based pet food quality can suffer due to a rapid drop in pH and acid shock, resulting in a lower quality final product. Balchem's PetShure® microencapsulated lactic and citric acids were able to successfully control the proliferation of Salmonella enterica without compromising the quality of the patty due to the controlled release of acid over time.

Manufacturers can include PetShure pH Control Systems as part of a comprehensive food safety strategy to create innovative, minimally processed, high-meat products that satisfy growing consumer demand for freshness and quality—without compromising safety or risking brand reputation.

References

Kiprotich, S., E. Altom, R. Mason, V. Trinetta, and G. Aldrich. 2023. Application of Encapsulated and Dry-plated Food Acidulants to Control Salmonella enterica in Raw Meat-Based Diets for Dogs. J Food Prot. 86(5). doi: 10.1016/j. jfp.2023.100077.

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[2]Pet Food Exchange. 2024. Dr. Billie Johnson.

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